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TACKLING AN IS EDUCATOR'S DILEMMA: A HOLISTIC MODEL FOR "WHEN" AND "HOW" TO INCORPORATE NEW TECHNOLOGY COURSES INTO THE IS/IT CURRICULUM

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ABSTRACT

To prepare their students for the rapidly changing and increasingly competitive job market, universities must constantly modify their Information Systems (IS)/Information Technology (IT) program curricula to incorporate relevant and emerging technologies in addition to computing fundamentals. The "haunting" conundrum that faces IS/IT educators is assessing whether an emerging technology is a "game-changing" development or something more transient. In addition, university curriculum approval proposals may be a barrier to timely incorporation of a new course. To solve the dilemma, the authors have developed a holistic model to provide strategic guidance for IS/IT educators to make a valid decision in terms of "when" to introduce a new course on emerging technology and "how" to incorporate the new course into an existing IS/IT curriculum. In addition, the authors present several examples demonstrating how the proposed models to IS/IT curriculum modification and new technology course insertion was useful in their curriculum decisions.

Keywords

IS/IT curriculum, curriculum design and development, emerging technologies, holistic model

INTRODUCTION

Information technology (IT) is constantly evolving and we have seen a series of revolutionary changes in IT throughout the world. The dynamic nature of the discipline means that educators in information systems and information technology (IS/IT) programs need to face the challenges of maintaining an up-to-date curriculum in an agile and continuous basis, to keep up with potential employers' expectations that college graduates should be adept at using the latest technology applications and tools as soon as they enter the workplace. To prepare their students for this rapidly changing and increasingly competitive job market, universities must constantly modify their IS/IT programs to incorporate relevant and emerging technologies in addition to covering the computing fundamentals.

However, because of the rate of change, the IS/IT curriculum can easily become bloated. In one of the recent featured columns in ACM Inroads, Walker (2011) raised a valid concern as "… the challenge for an undergraduate computing curriculum is how to accommodate much new material from our discipline in an already full undergraduate computing curriculum" (p.18). If we keep adding new requirements and courses whenever we identify a new topic useful for our students in seeking jobs, the curriculum would end up being inflated with trendy topics. Does it imply that we have to scale back some of the fundamental courses or expect more from incoming students?

Prior literature has identified dual purposes for the IS/IT educational programs, especially at the undergraduate level (Lightfoot, 1999; Noll and Wilkins, 2002; Topi et al., 2010). The IS/IT curricula not only "must give students the necessary skills in current industry practice to satisfy requirements for an entry-level position" (Lightfoot, 1999, p.43), but also must provide them the fundamental knowledge and skills to learn emerging technologies throughout their career (Davis, Gorgone, Couger, Feinstein, and Longenecker, 1997; Lee, Trauth, and Farwell, 1995). However, this IS/IT curriculum development rationale assumes that the appropriate technology can be easily identified by the curriculum development constituents such as educators, practitioners, and students and rapidly implemented. Unfortunately, this assumption barely holds true. IS/IT educators and researchers have struggled to find a balance between the required core and new, on-demand technology topics (Noll and Wilkins, 2002).

The "haunting" conundrum that faces IS/IT educators is assessing whether an emerging technology is a "game-changing" development or something more transient. The dilemma lies in that the time needed to develop, implement, and get approval for new technology courses may surpass the window of opportunity for some students to take advantage of those new technologies in the workplace. To solve the dilemma, the decision that educators must make is "when" to introduce a new course on emerging technology and “how” to incorporate the new course into an existing IT curriculum to avoid "bloating" the curriculum and to minimize the delays caused by lengthy approval processes.

The major aim of this study is to develop a systematic, agile framework that can be used to guide the IS/IT educators to tackle this dilemma. To achieve this, we analyze the practices used in IS/IT curricula design processes and identify “forces” that the IS educators need to examine before making “when” decisions. In addition, to facilitate the “how” component of the decision, we have developed a tactical model with a variety of entry points where the new technology topics can be developed and incorporated into the existing IS/IT curriculum in a timely manner. In addition, based on our own first-hand experiences, we present a series of case studies as examples demonstrating the results from applying the proposed models to IT curriculum modification and new technology course insertion.

PROBLEM IDENTIFICATION

The information technology sector is expressing concern over the "skills gap" of recent graduates from colleges and universities. There is much demand in all business sectors for specific skill areas (cloud computing, mobile application development, cybersecurity, to name a few) but employers also are looking for employees with a well-rounded education (McKendrick, 2011). In a tight economy, employers are looking for new hires who can "hit the ground running". Experienced employees no longer have the time to spend with new employees as many IT departments are very short of resources and more organizations are requiring 24 by 7 operation of their IT infrastructure.

As a result, it is challenging for the recent graduate to get their first job in IT. Most jobs that are advertised require at least two years of work experience as well as very specific job skills. Some prior studies have discussed such gaps and called for educators in the IS/IT field to take responsibilities of “designing a curriculum that prepares future IS professionals for this dynamic field” (Noll and Wilkins, 2002, p.144). According to a new survey of 376 employers executed by Unisphere Research (McKendrick, 2011), “a majority report that they depend on… universities and colleges to provide graduates with specific IT skills… as well as business skills…” (McKendrick, 2011, p2). We agree that colleges and universities should best prepare students for this highly-competitive job market of today but must also achieve a balance between fundamental computing skills, the "soft skills" such as communication and critical thinking skills, and knowledge and skills in new technologies.

Most universities provide excellent coverage of the fundamentals of computing and there are several guidelines from accrediting and other organizations as to what should be in the computing curriculum for IS, IT and computer science (ABET Computing Accreditation Commission, 2011; Lunt, Ekstrom, Gorka, Hislop, Kamali, Lawson, LeBlanc, Miller, and Reichgelt, 2008). The need for soft skills is coming more into focus as universities put more emphasis on the so called 21st century skills such as oral communication, writing, problem solving and critical thinking through a strong liberal arts core program or through major-specific course content (Carter, 2011; Dugan and Polanski, 2006; The Conference Board, 2006). However, the problem that remains is "when" and "how" to incorporate the new technology skills in the curriculum to meet industry skill requirements.

One example is the widespread incorporation of information security into the curriculum over the last ten years. Initially information security was added as a single course in the IS curriculum (Whitman and Matford, 2004), however, demand from industry and the government has now resulted in the creation of specific programs in cybersecurity, and even in specific topics within cybersecurity such as computer forensics or computer security administration (Wallace, Solano, Jamba, and Brown, 2009).

The process for curriculum change varies from one institution to another. Some common factors include the extent of the change (from course content updates to the addition of new programs), the impact on other programs at the institution, financial considerations (including requirements for new faculty), and the university "culture". Other factors that extend beyond the discipline include compliance with academic standards, balance between academic and career-oriented objectives, transferable skills development, and effective use of resources, including library resources (Green, Moffat, Sandergaard, and Zobel, 2004). University processes must be navigated to facilitate curriculum change and in IS/IT fields these may be constant. Not all change is sustainable though. There are many computing topics which never gain sufficient traction in the industry to warrant attention (e.g., Lightfoot, 1999).

To address those issues, this paper focuses on discussing a variety of factors to be considered when incorporating new technology in the curriculum and some practical guidance on tackling the question of "when" and "how" to make the curriculum change.

CONCEPTUAL FRAMEWORK

Our conceptual framework consists of two models: the strategic model for "when" to incorporate new technology topics into the curriculum and the tactical model for "how" to insert new courses into the existing curriculum.

Strategic Model for Making "when" Decisions

The authors have developed a holistic model with seven "forces" integrated as a foundation for making a valid "when" decision shown as in the following figure.

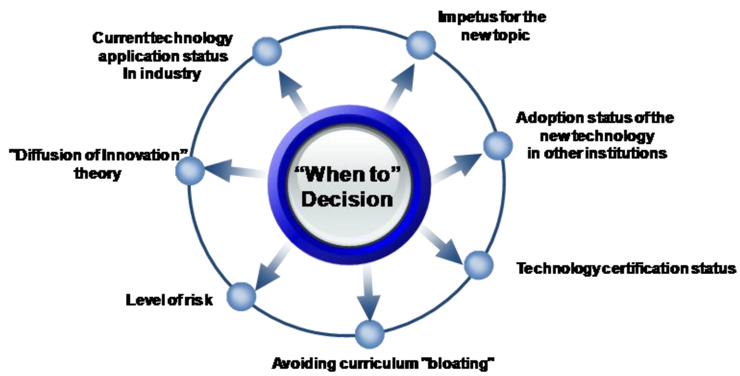

Figure 1. Strategic Model for Making "When" Decisions

The first factor is based on the widely cited *"Diffusion of Innovation" theory* which asserts that the adoption of technological innovation usually follows an S-shaped curve (Rogers, 1983). The curve starts with a small group of innovators adopting the innovation as it is introduced to market initially, gradually leveled up by the "early adopters" and "early majority" joining the force. The market gets saturated (i.e., the curve levels) as the "laggards" are left to adopt the innovation. This theory , sheds light on our curriculum design process and provides a macroscopic view to examine challenges IS/IT educators have to face: "…what is "core" to our discipline is not always stable; new and disruptive technologies will continually shape the curriculum as it does the discipline" (Babb and Abdullat, 2011, pg. 1). How do IS/IT educators make decisions on which new technology application topic to embrace and which to ignore? We follow the process outlined in The Innovator's Solution (Christensen and Raynor, 2003) and adapt it to the curriculum design. As such, we must start early and keep exploring new topics and technologies, with credible leadership (i.e. across the department, the school, and the university) and have a competent team of faculty with the right expertise.

The second factor included in the model is the *current technology application status in industry*. New technology often takes time to become prevalent in one or more sectors of industry or government. An example might be data visualization which arose as a new technology in the mid-1990s but only recently has become a required skill as "big data" becomes an emerging issue for many organizations. One of the most visible elements of technology application in industry is the inclusion of the technology in the job advertisements. For example, Hadoop emerged as one new technology associated with "big data". A search on www.indeed.com led to over 4,000 in December 2011 for jobs requiring Hadoop skills (compared to about 40,000 for "big data" generally). Another pointer to applicability in the industry is the extent of exposure in trade magazines such as Computerworld, Information Week, or CIO magazine. For example, Hadoop was the cover article in Information Week in November 2011 (Henschen, 2011). A third measure of industry acceptance is the availability of user groups for the technology and the number of members in those groups. Hadoop has over 1,000 users in a LinkedIn group (www.linkedin.com). These indicators might lead us to consider adding "big data", including Hadoop in particular, to our curriculum.

The third factor playing a role in the decision making process is the *impetus for the new topic*. Topics may be recommended by a number of constituents, including faculty, students, advisory board members, changes from accreditation bodies, or industry leaders. Accreditation guidelines must also keep up with industry requirements, although the frequency of change is slower. However, there are usually required changes for those accredited institutions and those seeking accreditation in the near future (Jackson, Hansen, Tang, Willemain and Ellis, 2009). Industry or advisory board guidance is also of high priority. For example, Google's Vice President of Engineering comments at a Google annual conference was the impetus behind the development of Web-based cloud and mobile computing in an undergraduate computer science program (Jackson et al., 2009). Faculty and student interest are also important since both are major players in the curriculum development process. Faculty members want to develop balanced, up-to-date curriculum materials and teach students fundamental knowledge as well as new technology applications. On the other hand, students "have the least power to influence the curriculum, yet stand to lose the most if it is poorly designed” (Lightfoot, 1999, pg. 44). They are more likely to take those elective classes which they are interested in or they believe would add value for their future career.

The fourth factor incorporated in the model is the *adoption status of the new technology topic in other institutions*. The authors recommend evaluating the implementation of courses or programs about the technology topic at equivalent, "aspirational" or major institutions. For example, Hadoop appears to be taught by some of the major cutting-edge computer science programs at large universities (including Carnegie Mellon University, University of Maryland, and University of California) but little information was found on its implementation in courses at small and medium size institutions. It was also interesting to note "how" the topic was implemented, sometime in a networking course (cloud computing), sometime in a distributed computing course, but also in a data management course. Adoption by another institution is often a consideration in university approval processes and should be thoroughly investigated and documented.

The fifth factor examined in our model is the *technology certification status*. In addition to an academic diploma, many employers look to technology certifications such as the vendor neutral offerings from CompTIA (A+, Network+, Security+, or Project+) or vendor-specific ones such as CCNA (Cisco Certified Network Associate) or MCP (Microsoft Certified Professional). The availability of a certification in a particular technology by a reputable organization such as CompTIA or a major technology corporation (such as Cisco or Microsoft) indicates that the technology has been subject to a formal evaluation process, which includes the need for the technology in the IT industry. Recent additions to CompTIA's certification include Cloud Essentials and Storage+, both topics being added to many university IS/IT curricula. For example, in information security, the Certified Information Systems Security Professional (CISSP) is considered as a critical certification for faculty and students (Frank and Werner, 2011). Certification status signals that the emerging technology might not be a “fad”. Also students may be more interested in the new topic if they knew that the associated certification can add much value to their resume and competency in the job market.

The sixth factor in the model is a consideration of *avoiding curriculum "bloating"* as discussed above. It has been recognized by many, including the accrediting bodies, that an undergraduate IS/IT program cannot cover all aspects of computing without expanding the curriculum to say six years (Walker, 2011). Courses must be always evaluated as core (required by all students) or elective (relevant to a specific field of interest for specific students). When examining a topic, it is important to consider not only where it can be included to support a course's overall objectives and themes, and also what can be removed from the existing curriculum to allow more current, on-demand technology topic to be integrated. A course or program that is overloaded will result in high dropout rates and poor grades. There is also the possibility of overlap between courses if faculty members add new topics without review and integration by the department. Without an overarching inspection and management process the IS/IT department may lose the cohesiveness of its program.

The last, but not least, factor in the model is the *level of risk.* Risks for adding new technology courses to a curriculum vary from one institution to another and often relate to its risk posture. For IS/IT departments, the first barrier to overcome may depend on approval by the business school, particularly for highly specific technology focused courses. Due to the intensively competitive and dynamic environment, time is of the essence to prepare students for the workplace. Hence, the agility of the curriculum approval process becomes a significant critical success factor (CSF). Another risk factor is the cost associated with any equipment, software requirements, or library support needs for the new course. Budgeting processes may delay a course for a year or more. Understanding the university's risk profile and curriculum change process is important in deciding "when" to start the curriculum revision process, often affecting the "how" decision discussed below.

Tactic Model for Making “how” Decisions

There are many points of insertion for a new technology topic, each with different timeframes for implementation as well as varying levels of approvals. The following matrix summarizes the proposed insertion approach into four quadrants.

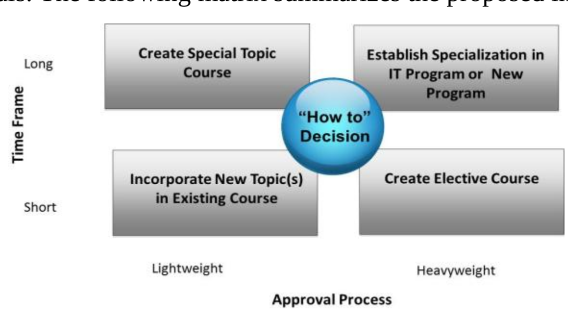

Figure 2. Tactic Model for Making “How” Decisions

Most programs include a "special topics" course which students can take as an elective. Those "special topics" courses that can function as prototypes, provide a platform from which faculty can judge students' interests, gather their requirements and feedback, and further adjust and refine the course content before developing a new course and getting it approved. In the aforementioned Hadoop case, if the technology continues to grow, we will offer a special topics course in Fall 2012 or Spring 2013. Another example is a special topics course introduced in Fall 2008 entitled "Virtual Reality in Business and Education (Programming in Second Life)", designed to meet an apparently growing use of Second Life virtual reality among business. The undergraduate course focused on teaching students how to program avatars to do some simple actions (such as raising their hands) and to use virtual reality to display business information. It required students to have taken a programming course and to work in groups to get an entire site programmed. The course was oversubscribed (about 27 students) and taught by a popular professor with a reputation for hands-on teaching. The faculty member reported some issues with the "unruly" nature of the Second Life platform, which led to her initiating a serious code of conduct for the students. In spite of high levels of involvement and positive feedback from the students, the course was not offered again, or introduced further into the curriculum, as the technology was seen to be a "fad" and did not appear to be increasingly used in business.

Another way to introduce the new topic is through offering a new course outside of the department. Our university requires all incoming freshman students to take an "inquiry" based course with topics to be selected by the individual faculty teaching the course. Each year, our department tries to offer at least one course with a technology focus. Because of the intense interest in developing the "mobile app" in industry, we decided to be a "first mover" to offer a mobile application development course. Taking non-IS/IT majors' background into account, the course uses "App Inventor" (Abelson, 2011) as the programming platform. We predict this topic will appeal to all majors and might be a recruiting tool for the IT program. It also allows us to offer a new technology course without "bloating" the IT curriculum.

The addition of a new course, or extensive revisions to an existing course, usually involves a more formal curriculum review process. At our institution this involves submitting a rationale for the change, a full syllabus and a detailed description of how the student will be assessed. Reviews are made by the department, school and the university curriculum committee. To submit a new course requires the implementation to be thoroughly thought out. The course is usually then implemented as an elective.

Because of the range of possibilities in the IS/IT field, most undergraduate programs involve a set of courses that can be taken as a "specialization". In our case, the IT program has specializations in interactive media, forensic computing, information systems, health care IT, and computer science. Developing a new specialty requires additional considerations; including ensuring the new option does not cannibalize the existing courses and make them under-enrolled. An example was the introduction of CISCO academy courses leading to the CCNA certification. To introduce the course, the university had to become an authorized CICO Academy and a professor had to become a certified CISCO instructor. This preparatory work was completed in Spring and Summer 2011 and the first course was offered as a special topics course in Fall 2011. The second CISCO course will be offered in Spring 2012, again as a topics course. At the same time, the faculty recognized the value of this in the curriculum, and submitted the courses, as well as a specialization in "computer networking and cyberescurity" to the curriculum committee for approval. The courses and specialization have been approved and will be fully incorporated into the curriculum in Fall 2012.

The most significant change would be to develop a new program. Increasingly students are looking for very specific credentials to meet their specific IS/IT interest and to meet the needs of employers who are increasingly looking for specific expertise. Programs are now offered in specific areas such as computer networking, Web development, and cybersecurity. Most institutions require a financial evaluation before a new program can be added.

The authors recommend carefully looking at the insertion point based on the technology being implemented, the timeframe available for implementation, and the institution's ability to approve the required curriculum change.

CONCLUSION

The purpose of this study is to examine the dilemma that faces the IS/IT educator in curriculum change. We have built a holistic framework for agile curriculum development that addresses the question of "when" and "how" to introduce new technology to keep a balanced and sustainable curriculum. This study contributes to the IS/IT curriculum development in several ways. First, by integrating seven factors from "diffusion of innovation theory" to the level of risk, we add to the literature on curriculum development. Second, we not only shed light on the issue of "when", but also offer insights on "how" to implement the insertion. Finally, this study provides a granular and deeper understanding of the issue and yields pragmatic guidance for IS/IT educators.

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